Lawrence Hydroelectric Power Project (FERC. No. 2800)

Proposed Study Plan Meeting

January 4, 2024

Project Overview

- Essex Company, LLC (Essex) is the Licensee and operator of the 16.8 megawatt (MW) Lawrence Hydroelectric Project (FERC No. 2800) (Project or Lawrence Project)
- The Project is located along the Merrimack River in the City of Lawrence in Essex County, Massachusetts
- The existing license for the Project was issued by the Federal Energy Regulatory Commission's (FERC or Commission) with an effective date of December 1, 1978, for a term of 50 years. The existing license expires on November 30, 2028.

Meeting Objectives

- Essex is pursuing a new license for the Project from the Federal Energy Regulatory Commission (FERC or Commission) in accordance with FERC's Integrated Licensing Process (ILP) at 18 CFR Part 5.
- Pursuant to the ILP, Essex developed a Proposed Study Plan (PSP) that was filed with the Commission on November 28, 2023.
- The objectives of this PSP Meeting are to:
  - Clarify the PSP and any stakeholder information gathering or study requests;
  - Address any outstanding issues regarding the PSP; and
  - Review process plan and schedule and key dates.

Meeting Agenda

Agenda Item/Study	January 4th Schedule
Introductions and Overview	9:00 AM – 9:15 AM
Upstream Anadromous Fish Passage Assessment	9:15 AM – 10:00 AM
Upstream American Eel Passage Assessment	10:00 AM – 10:45 AM
American Eel Upstream Passage Siting Study	10:45 AM – 11:30 PM
Lunch Break	11:30 AM – 12:30 PM
Project Operations and Fish Stranding Study	12:30 PM – 1:15 PM
Freshwater Mussel Habitat Assessment and Survey	1:15 PM – 2:00 PM
Break	2:00 PM – 2:15 PM
Water Quality Study	2:15 PM – 3:00 PM
Three-Dimensional Computational Fluid Dynamics Modeling	3:00 PM – 3:45 PM
Review of Study Requests Not Adopted	3:45 PM – 4:45 PM

Meeting Agenda

Agenda Item/Study	January 5th Schedule
Recreation Facilities, Use, and Aesthetics Study	9:00 AM – 9:45 AM
Historically Significant Waterpower Equipment Study	9:45 AM – 10:30 AM
Condition Assessment of Historic Properties and Associated Canal System	10:30 AM – 11:15 PM
Lunch Break	11:15 PM – 12:15 PM
Review of Study Requests Not Adopted	12:15 PM – 1:30 PM

Process Plan and Schedule

Major Milestones	Responsible Party	Dates
File PAD and NOI (18 CFR §5.5(d))	Essex	June 16, 2023
File Proposed Study Plan (PSP) (18 CFR §5.11)	Essex	November 28, 2023
Study Plan Meeting(s) (18 CFR §5.11(e))	Essex	January 11, 2024
Comments on PSP (18 CFR §5.12)	Stakeholders	March 11, 2024
File Revised Study Plan (RSP) (18 CFR §5.13(a))	Essex	April 10, 2024
Comments on RSP (18 CFR §5.13(b))	Stakeholders	April 25, 2024
Issuance of Study Plan Determination (18 CFR §5.13(c))	FERC Director	May 10, 2024
Initial Study Report (18 CFR §5.15(c))	Essex	April 26, 2025
File Updated Study Report (18 CFR §5.15(f)) (if necessary)	Essex	April 26, 2026
File Draft License Application (18 CFR §5.16(a))	Essex	July 3, 2026
File Final License Application (18 CFR §5.17)	**Essex**	**November 30, 2026**

Project Location and Facilities

Project Operations

- The Lawrence Project operates in a run-of-river mode and has no useable storage capacity.
- The Project's installed capacity is 16.8 MW
- Project facilities and descriptions include:
  - The Essex Dam is a 900-foot-long and 35-foot-high masonry gravity dam that includes a 900-foot-long spillway with a crest elevation of 39.17 feet National Geodetic Vertical Datum 1929 (NGVD 29) and three 5-foot-high pneumatically-operated crest gates;
  - A 655-acre impoundment with a normal maximum water surface elevation of 44.17 feet NGVD 29;
  - A powerhouse located at the end of a small forebay adjacent to the south abutment of the Essex Dam that contains two turbine-generator units
  - A canal system that originates at the Essex Dam and consists of the approximately 5,300 foot long North Canal and the 2,750 foot long South Canal.
  - Fish passage facilities integral with the powerhouse, including a fish elevator and downstream fish bypass, and an eel ladder at the right.
  - A single-circuit, underground/underwater 23.0-kilovolt (kV) transmission line to the Massachusetts Electric Company's Lawrence No. 1 substation

Project Operations

- The Lawrence Project operates in a run-of-river mode with an installed capacity of 16.8 MW
- Pursuant to Article 32, the Project maintains a minimum flow of 951 cfs or inflow, whichever is less, as measured immediately downstream from the Project
- When river flows exceed the hydraulic capacity of the Essex units (approximately 4,000 cfs per unit or 8,000 cfs for both units), excess flows are discharged over the spillway.
- Under extreme flood conditions (river flows > 52,000 cfs) the crest gate system is fully lowered using manual or automatic control to pass excessive river flows and is adjusted up to restore normal pond height after any high-flow or flood event has receded.

Overview of Proposed Study Plan

Study Plan Overview

- PSP was filed with FERC on November 28, 2023 pursuant to 18 C.F.R. § 5.11
- Notification of filing and providing electronic location of document distributed to mailing list
- The PSP describes Essex's approach to conducting the studies, taking into consideration FERC study criteria, formal study requests, and written comments of agencies and stakeholders
- ILP study requests were submitted by:
  - U.S. Fish and Wildlife Service (USFWS)
  - New Hampshire Fish and Game Department (NHFG)
  - Massachusetts Division of Marine Fisheries (MADMF)
  - Massachusetts Department of Environmental Protection (MADEP)
  - Massachusetts Division of Fisheries and Wildlife (MassWildlife)
  - Federal Energy Regulatory Commission (FERC)
  - National Marine Fisheries Service (NMFS)
  - Groundwork Lawrence (GWL)
  - The Nature Conservancy (TNC)
  - National Park Service (NPS)
  - Greater Lawrence Sanitary District (GLSD)
  - Lawrence Community Works (LCW)
  - Merrimack River Watershed Council (MRWC)

(18 CFR § 5.9(b)): FERC's Criteria for Study Requests Under the ILP

- Describe the goals and objectives of each study proposal and the information to be obtained.
- If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.
- If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.
- Describe existing information concerning the subject of the study proposal, and the need for additional information.
- Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.
- Explain how any proposed study methodology is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.
- Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

PSP and Revised Study Plan: Stakeholder Participation

- Comments on the PSP are due to FERC by March 11, 2024. Proposed modification to the PSP must address the seven FERC study criteria in 18 CFR § 5.9(b)
- Formal comments should be filed with FERC and include the FERC Project number in the subject line (P-2800). These documents will also be available from FERC's elibrary under Docket P-2800.

- Stakeholders can contact Essex with questions or comments:

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Patriot Hydro, LLC
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- Essex will file the Revised Study Plan (RSP) on or before April 10, 2024.

Study Plan Overview: Proposed Studies

- Studies Proposed by Essex:
  - Upstream Anadromous Fish Passage Assessment
  - Upstream American Eel Passage Assessment
  - American Eel Upstream Passage Siting Study
  - Project Operations and Fish Stranding Study
  - Freshwater Mussel Habitat Assessment and Survey
  - Water Quality Study
  - Three-Dimensional Computational Fluid Dynamics (CFD) Modeling
  - Recreation Facilities, Use, and Aesthetics Study
  - Historically Significant Waterpower Equipment Study
  - Condition Assessment of Historic Properties and Associated Canal System

Upstream Anadromous Fish Passage Assessment

Upstream Anadromous Fish Passage:
Goals and Objectives

- Study Goal:
  - Determine the impact of the Lawrence Project on the upstream migration of anadromous adult alosines (i.e., alewife [*Alosa pseudoharengus*], blueback herring [*Alosa aestivalis*], and American shad [*Alosa sapidissima*]).
- Specific Objectives:
  - Determine approach of upstream migrants from the downstream release location towards the Project fishway under a range of operational/river conditions.
  - Determine tailrace residence duration of upstream migrants following arrival downstream of the Project.
  - Estimate the nearfield attraction efficiency, entrance efficiency, internal efficiency, and overall efficiency of the existing upstream fish lift under a range of operational/river conditions and with both entrances in the open position.
  - Inform on fish lift entry (i.e., frequency, timing, and location of entry events).

Upstream Anadromous Fish Passage:

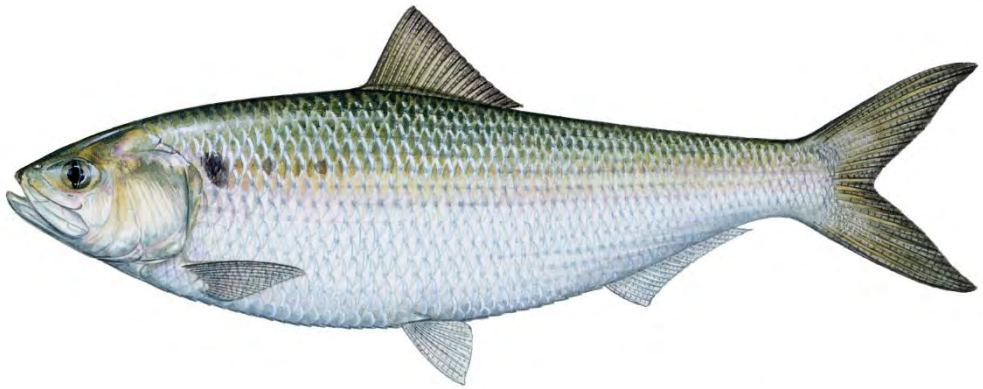
Study Area

- Section of the Merrimack River from Haverhill Riverside Park up to Project impoundment
- Emphasis on existing upstream fish lift facility

Upstream Anadromous Fish Passage:

Study Methodology – Sample Size

- Proposed upstream passage evaluation will be conducted using radio-telemetry
- Focus on adult alosines – river herring and American shad
- Sample Size Determination:
  - Targeted number of 100 fish/species to (at minimum) enter the near-field region of existing upstream fishway
  - Assumed 21% and 33% fallback rates for herring and shad
    - Based on range noted during study plan development for Lowell and more conservative than fallback rates observed for these species during 2020 Lowell tagging
  - Known concern related to predation of test fish due to presence of striped bass in reach downstream of Essex Dam
    - Lack any site-specific predation rates on herring or shad
    - Assumed 50% loss to predation for river herring and 25% loss to predation for shad
  - When adjusted for fallback and predation loss
    - Proposed collection and tagging of 185 adult river herring
    - Proposed collection and tagging of 165 adult American shad



Upstream Anadromous Fish Passage:

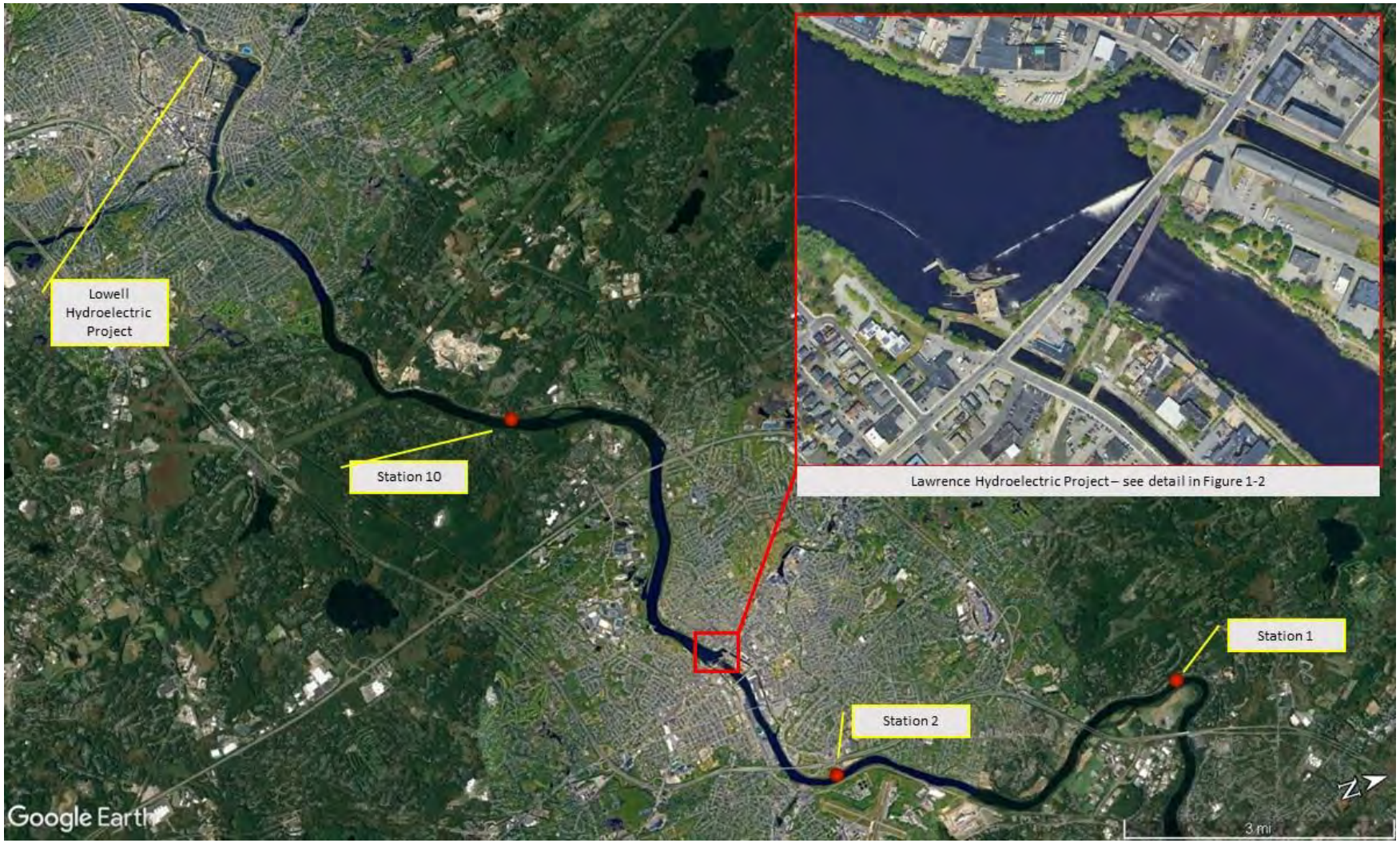
Study Methodology – Tagging and Release

- Test fish collected via boat electrofish Merrimack River downstream of Project – Union St. Duck Bridge to 1st 495 crossing
- Visually assessed for species and condition for tagging
- Collect TL and sex
- Insert radio-transmitters gastrically following standard techniques
- Immediate return to Merrimack River – record release time and GPS location

- Sigma-Eight model TX-PSC-I-80 or TX-PSC-I-80D transmitters
  - TX-PSC-I-80 measures approximately 10 x 10 x 27 mm, weighs 4.2 g, and has an estimated battery life of 64 days when set at a 2.0 second burst rate
  - TX-PSC-I-80D measures approximately 10 x 10 x 22 mm, weighs 3.3 g and has an estimated battery life of 64 days when set at a 2.0 second burst rate

Upstream Anadromous Fish Passage:

Study Methodology – Stationary Receiver Array



- Downstream receiver stations to inform on fallback or departure following tagging/residence
- Upstream receiver station to inform on continued migration following passage

Upstream Anadromous Fish Passage:

Study Methodology – Stationary Receiver Array

- "Approach"
- Tailrace/Nearfield
- River & street side entrances
- Lower entrance flume near hopper
- Upper exit flume – downstream end
- Upper exit flume – upstream end

Upstream Anadromous Fish Passage:

Study Methodology – Additional Data Collection

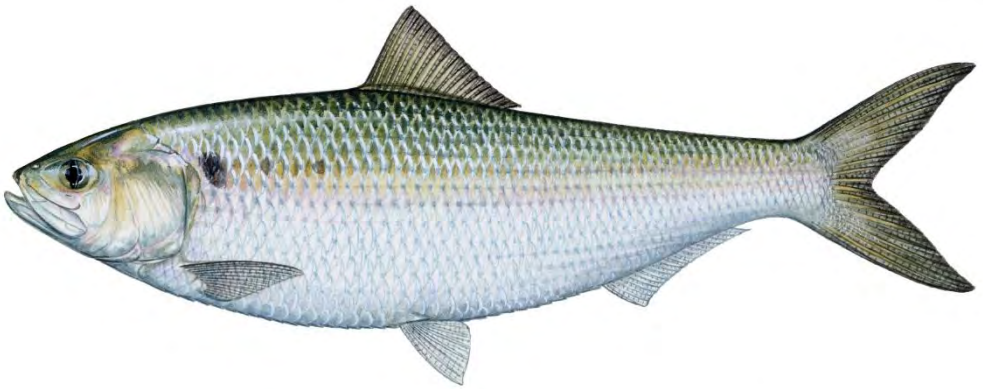
- River temperature
- Project operations data
  - Inflow
  - Generation discharge
  - Spill discharge and location
  - Downstream bypass status
  - Canal status
- Daily fish lift observations
  - AWS gate setting
  - AWS discharge
  - Entrance gate setting
  - Entrance drop
  - V-trap opening

Upstream Anadromous Fish Passage:

Study Methodology – Data Analysis

- Post Release Behavior: classification of individual fish based on post-release movement patterns (i.e., fallback versus approach)
- Seasonal and temporal distribution of arrival at Lawrence Project
- Time at Large: calculated as duration of time from detection at approach until (1) upstream passage at the lift, or (2) permanent movement DS and away from Project
- Passage Attempts: quantify count and duration based on pattern of detections between nearfield, entrances, and internal detection locations
- Fish Lift Effectiveness:
  - Nearfield efficiency
  - Entrance efficiency
  - Overall lift efficiency

- Assemble encounter histories for each fish
- Input for CJS model to evaluate passage success estimates between adjacent receiver stations as fish moved upstream



Upstream Anadromous Fish Passage:

Schedule, Level of Effort, and Cost

- Evaluation of upstream adult alosine passage is expected to be conducted during spring 2025.
- Essex anticipates filing the Report on the Upstream Anadromous Fish Passage Assessment with the Commission concurrent with the USR in April 2026.
- Essex estimates the cost of the Upstream Anadromous Fish Passage Assessment to be in the range of $170,000.

Upstream American Eel Passage Assessment

Upstream American Eel Passage Assessment:
Goals and Objectives

- Study Goal:
  - Evaluate the effectiveness of the existing upstream American eel (*Anguilla rostrata*) passage facilities at the Project.
- Specific Objectives:
  - Assess attraction to the south side eel trap and north side eel lift.
  - Determine the proportion of marked eels entering the south side eel trap or north side eel lift which then successfully ascend upstream (i.e., internal efficiency).
  - Review the length frequency distribution of marked eels released downstream of the south side eel trap or north side eel lift with that of the subset which successfully pass upstream via each structure.
  - Estimate the travel time for a marked eel to move from the downstream entrance of the south side eel trap's ramp or north side eel lift to the upstream collection facility.
  - Estimate the retention effectiveness of the collection traps associated with the existing eel passage facilities at the south side eel trap and north side eel lift.

Upstream American Eel Passage Assessment:

Study Area

- Section of the Merrimack River located immediately downstream of Essex Dam
- Emphasis on existing eel passage facilities - north side eel lift and south side eel trap
- Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

Upstream American Eel Passage Assessment:
Study Methodology – Nighttime Observations

- Will provide a qualitative assessment of attraction to the existing eel passage facilities
- Monthly events during eel passage months of June, July, and August
- Will follow methodology developed during 2014 evaluation of south side eel trap
  - Conduct ~ two hours following sunset
  - Examine internal counts of eels
    - Remove plywood covers and enumerate eels by sections using red light
    - Classify eels into size groups (0-6, 6-12, and 12+ inches)
  - Nearfield observations of ledge areas adjacent to entrance
    - Conducted using spotlights
    - Focus on areas of eel concentration as eels attempt to approach trap
    - Note areas of congregation and estimate size distribution
  - Conduct comparable observations set at the north side eel lift

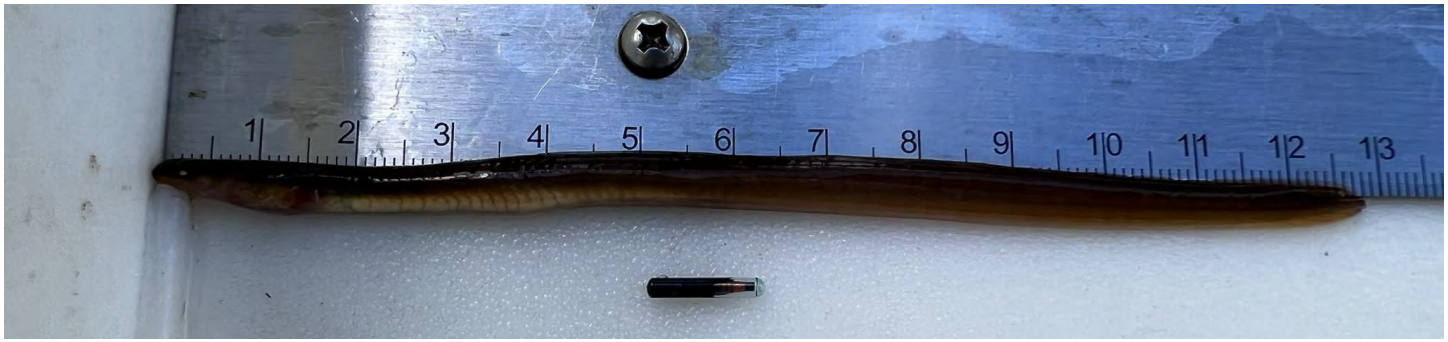
- Related data to include
  - Air and water temperature
  - Moon phase and weather conditions
  - Project operations

Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

Upstream American Eel Passage Assessment:

Study Methodology – Internal Efficiency

- Quantitative evaluation of internal efficiency
- Evaluate entry and exit of PIT tagged eels in and out of the south side eel trap and north side eel lift
- Will utilize a series of synchronized HDX single antenna readers
  - Will install and maintain four readers/antennas per existing passage facility
  - Two antennas installed immediately adjacent to one another at both entrance and exit
  - Will permit:
    - redundancy to help ensure detection of an individually tagged eel moving through either the entrance or exit
    - determination of directional movement of a tagged individual based on the sequence of detection at the two adjacent antennas



Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

Upstream American Eel Passage Assessment:
Study Methodology – Internal Efficiency

- PIT-tags – Oregon RFID 12 mm HDX
- Abdominal insertion via small scalpel incision
- Targeted sample sizes:
  - South side eel trap – 125 individuals greater than 4.5 inches and less than or equal to 6 inches
  - South side eel trap – 125 individuals greater than 6 inches
  - North side eel lift – 125 individuals greater than 4.5 inches and less than or equal to 6 inches
  - North side eel lift – 125 individuals greater than 6 inches

- Test eels to be obtained from downstream of Lawrence and maintained onsite in flow-through tank system
- Released near base of each upstream eel fishway and allowed to volitionally enter structure (sunset release times)
- Target 2-3 release events per passage structure at Lawrence

Note: No eels smaller than 4.5 inches will be tagged based on previous study findings – Mueller et al. 2017, Normandeau 2023

Upstream American Eel Passage Assessment:

Study Methodology – Collection Tank Retention

- Evaluate retention rate of collection tanks at south side eel trap and north side eel ramp
- Mark-recapture approach:
  - Mark 20 eels using VIE and place in collection bucket at each trap
  - Allow to remain overnight for standard duration between trap checks
  - Upon return visit – identify and count number of marked eels in the trap
- A total of two mark-recapture events will be conducted at each eel facility

Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

Upstream American Eel Passage Assessment:
Study Methodology – Data Summary

- Qualitative nearfield evaluation
  - Summary of estimates (by size class) for eels in the eel passage structures and in nearfield areas
- Quantitative internal efficiency
  - Date/time of entry into eel passage structure
  - Rate of passage based on percent of eels detected at entrance versus exit
  - Examine size structure of eels passing versus that of eels entering (size effects?)
  - Duration of passage as measured from detection at entrance versus exit
- Quantitative trap retention rate
  - Estimated as the percentage of VIE marked eels recovered from the tank at the end of each holding period (pooled across both holding periods).

Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

Upstream American Eel Passage Assessment:

Schedule, Level of Effort, and Cost

- Evaluation of upstream American eel passage is expected to be conducted during June-August 2024.
- Essex anticipates filing the Report on the Upstream American Eel Passage Assessment with the Commission concurrent with the ISR in April 2025.
- Essex estimates the cost of the Upstream American Eel Passage Assessment to be in the range of $60,000.

Upstream American Eel Passage Siting Study

American Eel Upstream Passage Siting Study:
Goals and Objectives

- Study Goal:
  - Evaluate the potential need for additional permanent upstream American eel (*Anguilla rostrata*) passage facilities at the Project.
- Specific Objectives:
  - Inform on the spatial distribution and relative abundance of juvenile eels downstream of the Project and to identify the potential need for any new locations appropriate for a future upstream eel passage structure(s).

American Eel Upstream Passage Siting Study:

Study Area

- Section of the Merrimack River located immediately downstream of Essex Dam
- Emphasis on Project areas without existing upstream eel pass structures
- Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

American Eel Upstream Passage Siting Study:
Study Methodology – Nighttime Visual Surveys

- Will be conducted once weekly for 10-week period starting in early June
- Visual based surveys conducted ~2 hours after sunset
- Emphasis on areas characterized by downstream conveyance of water which may be attractive to eels AND are safely accessible to field staff
- Search areas may include north and south abutment areas, downstream side of North and South Canal gatehouses, North Canal discharge area
- Target data to include:
  - Date and time of search event,
  - List of safely accessible survey areas included in each survey (may vary from week to week based upon site conditions),
  - Estimate of numerical abundance and size classes by survey area,
  - Weather conditions,
  - Air and water temperatures,
  - Moon phase, and
  - Project discharge (turbines, fish passage facilities).

Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

American Eel Upstream Passage Siting Study:

Study Methodology – Backpack Electrofish Surveys

- Will be conducted twice during the 10-week period survey period
- Will focus on safely accessible survey areas and is intended to provide supplemental observations to better describe relative abundance and body size distribution
- Conducted during daylight hours for safety reasons
- Target data to include:
  - presence/absence of juvenile eels
  - count of individuals (by size class)
  - duration of sampling (i.e., seconds of sample time to allow for calculation of CPUE)
  - water conductivity/backpack settings (frequency (Hz), voltage (vDC), etc.)
  - GPS coordinates

Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

American Eel Upstream Passage Siting Study:
Study Methodology – Temporary Eel Traps

- Operation of up to two temporary eel traps during the 10-week period survey period
  - Placement TBD with MRTC during site visit prior to start of 10-week survey period
- Anticipate a standard ramp design with collection bucket
- Trap check every 1-3 days during period
- Trap check data to consist of:
  - Date and time of ramp check
  - Count of live eels by size class
  - Count of any observed eel mortalities in area
  - Air and water temperatures
  - Project discharge
  - Condition of eel ramp
    - e.g., fishing/not fishing, debris issues, vandalism, etc.
  - Observations of predator activity
- Will incorporate two separate trap retention evaluations
  - Same VIE methodology as for permanent structures

Note: potential locations considered under this study will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

American Eel Upstream Passage Siting Study:

Schedule, Level of Effort, and Cost

- The American Eel Upstream Passage Siting Study is expected to be conducted during June-August 2024.
- Essex anticipates filing the Report on the American Eel Upstream Passage Siting Study with the Commission concurrent with the ISR in April 2025.
- ISR will summarize Year 1 results – Essex to consult with MRTC on potential need for additional temporary eel trap sampling during Year 2
- Essex estimates the cost of the American Eel Upstream Passage Siting Study to be in the range of $60,000.

Project Operations and Fish Stranding Study

Project Operations and Fish Stranding Study: Goals and Objectives

- Study Goal: The goals of the study are (1) to provide information on how the Project is operated in a ROR mode, including a review and evaluation of existing operational generation records, minimum flows, Merrimack River flows, and impoundment elevations; and (2) to evaluate influence of Project operations and maintenance on potential fish stranding areas downstream of the dam and Project tailrace
- Specific Objectives:
  - Summarize the operational conditions of the Project over the five-year period of record (Jan 1, 2019 – December 31, 2023), including impoundment elevations, generation records, minimum flows, and maintenance events;
  - Develop tables and graphs as appropriate to illustrate how ROR operations, minimum flow requirements, and other operational requirements are maintained at the Project; and
  - Analyze the Project operations and results of the CFD Study as they relate to flow conditions, hydraulic processes, and potential fish stranding sites below the Project Dam and powerhouse..

Project Operations and Fish Stranding Study: Study Area

- The study area includes the Lawrence Project impoundment, tailrace, spillway, and downstream reach below the Essex Dam.

Project Operations and Fish Stranding Study: Background and Existing Information

- Existing relevant and reasonably available information regarding Project operations and fish and aquatic resources are presented in sections 4.4 and 5 of the PAD.

- In their comment letters, MADMF, NHFG, MassWildlife, and USFWS identify and describe potential fish stranding events below the Project dam in 2019 and 2023.

Project Operations and Fish Stranding Study: Project Nexus

- Operation of the Project influences water elevations and river flows within and immediately downstream from the Project boundary and may have effects on aquatic resources below the Project dam and tailrace.

Project Operations and Fish Stranding Study: Study Methodology

- Essex proposes to perform this study in two phases, with Phase 1 designed as a desktop analysis of Project operations and Merrimack River flows and Phase 2 as a desktop evaluation of the combined results of Phase 1 and the results from the CFD modeling study.
- Phase 1 – Operational Data Review
  - Essex will review, compile and analyze historical operational data for the past five years (Jan 1, 2019 – December 31, 2023). These data will include the following, where available:
    - impoundment elevation
    - unit status (i.e. online/offline)
    - Project inflows as estimated from the United States Geological Survey (USGS) gage Merrimack River at Lawrence, MA – 01100500 and data as provided by the National Weather Service (NWS) Station Merrimack River at Lawrence located at Union St (Duck) Bridge13
    - crest gate operations
    - individual unit flows
    - total powerhouse outflow, including outflows from fish passage facilities
    - total estimated outflow below the Project tailrace elevations
    - flows downstream at (USGS) gage Merrimack at Haverhill, MA – 01100693.
- Where existing information is available, Essex will document maintenance or operational incidents leading up to the 2019 and 2023 fish stranding events identified by MADMF, NHFG, MassWildlife, and USFWS. The above data will be reviewed to provide a description of flows, water levels, and generation in a concise narrative with additional tables and graphs as appropriate to illustrate how operational requirements are maintained at the Project.

Project Operations and Fish Stranding Study: Study Methodology

- Phase 2 – Project Operations and CFD Modelling
  - Using the Operational Data Review performed for Phase 1, Essex will analyze the results of the CFD study to examine potential fish stranding sites below the Project dam. Phase 2 will incorporate the bathymetry, depth, and 3D flow data collected as part of the CFD study to map potential stranding sites and describe operational influences (if any). As necessary to complement the CFD information, Essex will review and interpret aerial imagery of the Project area to better define the potential fish stranding sites further downstream below the Essex dam.

Project Operations and Fish Stranding Study: Analysis and Reporting

- Essex anticipates that the Project Operations and Fish Stranding Study report will include the following elements:
  - Project information and background
  - Study area,
  - Methodology
  - Study results
  - Analysis and discussion
  - Any agency correspondence and or consultation, and
  - Literature cited.

Project Operations and Fish Stranding Study: Schedule, Level of Effort, and Cost

- The Phase 1 of this desktop assessment of Project operations can be conducted during the 2024 study season.
- Phase 2 of this desktop assessment will be conducted during the 2025 study season following completion of the CFD modelling study.
- Essex anticipates filing the final report concurrent with the USR.
- The preliminary estimated cost for this study is $30,000 - 40,000.

Freshwater Mussel Habitat Assessment and Survey

Freshwater Mussel Habitat Assessment and Survey:

Goals and Objectives

- Study Goal:
  - Determine the presence, location, and species of freshwater mussels that inhabit Project-affected aquatic habitats.
- Specific Objectives:
  - Conduct field survey to characterize the distribution, composition, and relative abundance of freshwater mussels and non-native bivalves in the Lawrence Project impoundment.
  - Assess potential host-fish for documented freshwater mussel species through review of currently available fish data collected for the Merrimack River in the vicinity of the Essex Dam.

Freshwater Mussel Habitat Assessment and Survey:

Study Area

- Project impoundment - the mainstem Merrimack River from the from the Essex Dam 9.8 miles upstream to the area immediately downstream of the Lowell Hydroelectric Project
- North and South Canals
- Note: Project canals will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations

Freshwater Mussel Habitat Assessment and Survey:

Methodology

- Semi-quantitative, timed searches
- Snorkel, view bucket, SCUBA – depending on depth
- May 15-September 30 mussel survey window
- Proposed 21 search locations for Project impoundment
  - 50 m transect parallel to shore and out to the 5-ft depth contour
- Canal searches – to be determined following onsite review of health and safety concerns with access or entering

Freshwater Mussel Habitat Assessment and Survey:
Methodology

- Search Location Methodology
  - Surveyors will move from downstream to upstream within each 50 m transect
  - Conduct tactile/visual searches to collect all mussels
- Search location data to consist of:
  - Total survey time expended
  - Numbers and shell length of any state-listed species
  - Numbers of other live mussel species (relative abundances for common species observed in high numbers)
  - Search location GPS coordinates
  - Range of water depth
  - Water clarity
  - Estimate of substrate composition (Wentworth Scale)
  - Estimate of aquatic vegetation presence
  - Presence of any invasive mollusk species (e.g. Corbicula)

Eastern Elliptio

Eastern Floater

Eastern Lampmussel

Freshwater Mussel Habitat Assessment and Survey:

Schedule, Level of Effort, and Cost

- The Freshwater Mussel Habitat Assessment and Survey is expected to be conducted during summer-fall 2024.
- Essex anticipates filing the Report on the Freshwater Mussel Habitat Assessment and Survey with the Commission concurrent with the ISR in April 2025.
- Essex estimates the cost of the Freshwater Mussel Habitat Assessment and Survey to be in the range of $40,000.

Water Quality Study

Water Quality Study:
Goals and Objectives

- Study Goal:
  - Collect sufficient data to understand current water quality conditions at the Project, assess the designated uses for the two Assessment Units (MA84A-03 and MA84A-04) potentially affected by the Project, and assess any effects of Project operations on water quality in the affected Assessment Units.
- Specific Objectives:
  - Measure dissolved oxygen (DO), water temperature, pH, and Secchi disk depth at the deepest known spot in the impoundment.
  - Measure DO, water temperature, and pH at eleven locations under various river flow, river temperature, and project operating conditions to determine the spatial and temporal effects of project operations on water quality. Monitoring locations will include:
    - Five locations upstream of the Project dam.
    - One location in the reach immediately downstream of the dam.
    - One location downstream of the confluence of the tailrace.
    - Two locations each in both the North and South Canal.

Water Quality Study:

Study Area

- Merrimack River located immediately upstream of the Essex Dam
- Essex Dam Project development area including the main channel, tailrace, North Canal, South Canal, and the Merrimack River immediately below the Project

Water Quality Study:
Methodology – Continuous Monitoring

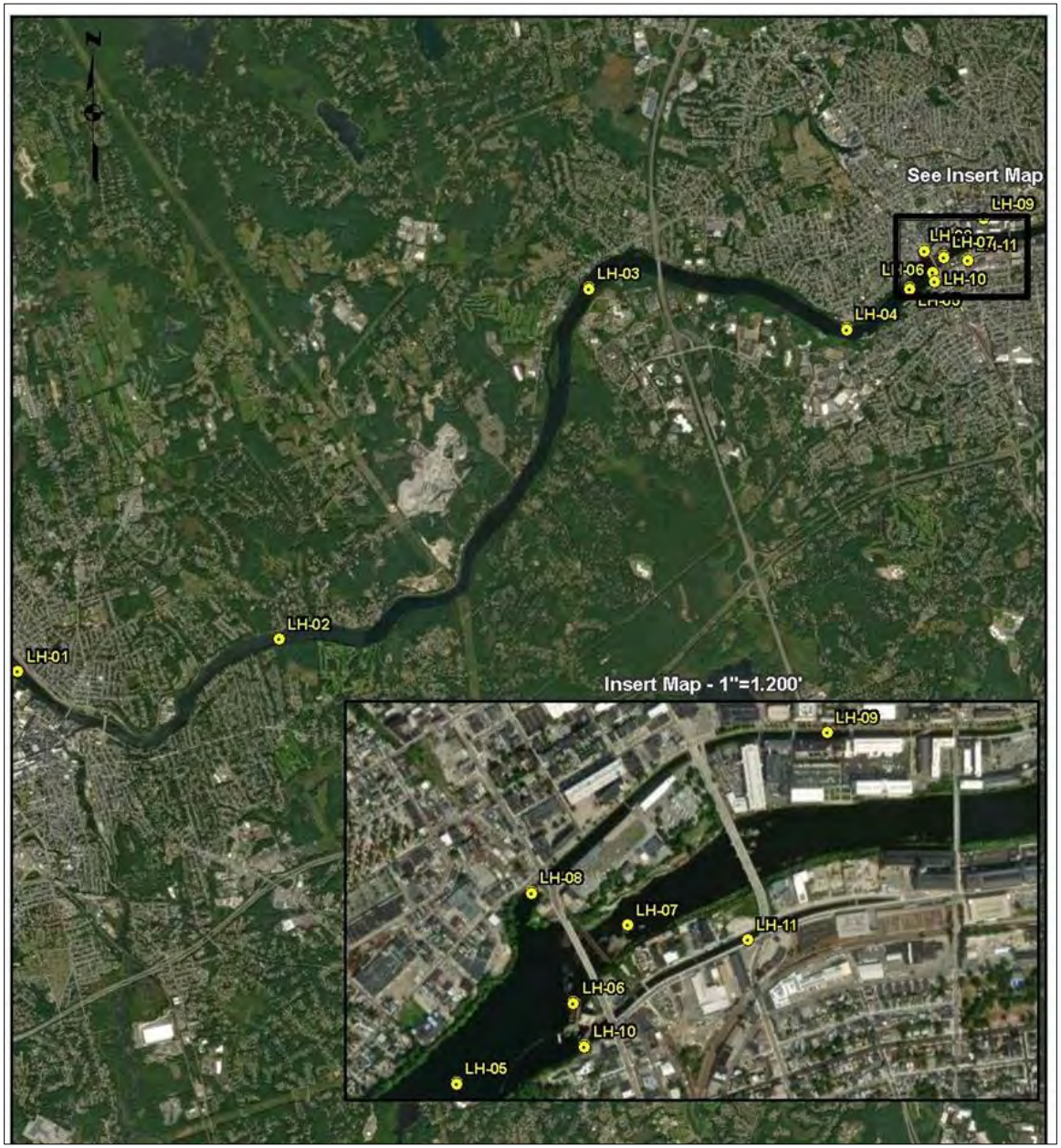
- Water quality instruments will be deployed at eleven locations within the Project area
  - Positioned within the epilimnion of the water column (under stratified conditions) or at a mid-depth position (under unstratified conditions)
  - Onset Hobo U26-001 DO & temperature logger, Onset Hobo MX2501 pH & temperature logger
- Data collected continuously from June 1 through September 30
- Set to collect temperature, dissolved oxygen and pH at 15-minute intervals
- Instruments retrieved, downloaded, cleaned and calibrated once weekly for duration

Water Quality Study:

Methodology – Continuous Monitoring

Eleven locations within Project area – to be finalized in QAPP

- US Impoundment (LH-01)
- Upper Impoundment (LH-02)
- Middle Impoundment (LH-03)
- Lower Impoundment (LH-04)
- Impoundment (deep) (LH-05)
- River below dam (LH-06)
- River confluence (dam/tailrace) (LH-07)
- North Canal Gatehouse (LH-08)
- North Canal midpoint (LH-09)
- South Canal Gatehouse (LH-10)
- South Canal midpoint (LH-11)



Water Quality Study:
Methodology – Vertical Profiles

- Impoundment vertical profiles:
  - Collected once per week at representative deep spot within impoundment
    - No sampling to occur at any location inside of boater barrier
    - Deep spot to be identified by sounding measurements collected along longitudinal center line (then refined bank to bank)
  - Collected data will include both temperature and dissolved oxygen
  - Readings taken:
    - 0.1 m below surface
    - 0.5 m below surface
    - Every 0.5 m until 0.5 m off of bottom
    - If total depth > 15 m, increase interval to 1 m below thermocline
  - Secchi disc depth to be recorded

Water Quality Study:

Schedule, Level of Effort, and Cost

- The Water Quality Study is expected to be conducted during summer 2025.
- As requested by MADEP, Essex will develop a draft QAPP for review and approval prior to the onset of any field sampling (anticipated to occur during 2024).
- Essex anticipates filing the Water Quality Study with the Commission concurrent with the ISR in April 2025.
- Essex estimates the cost of the Water Quality Study to be in the range of $80,000.

Three-Dimensional Computational Fluid Dynamics Modeling

Three-Dimensional Computational Fluid Dynamics Modeling: Goals and Objectives

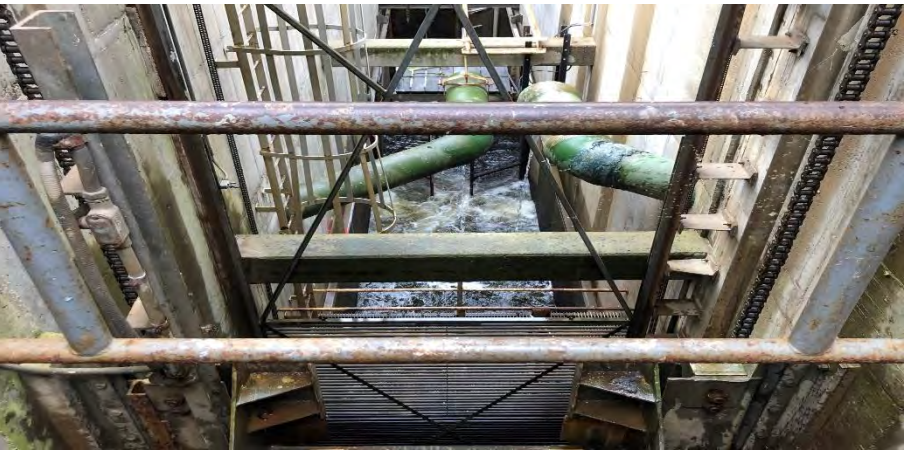
- Study Goal: Determine the flow field conditions that exist in and around the Lawrence Project's upstream and downstream migratory fish passage routes. This is anticipated to aid in the interpretation of conditions for the guidance of migrating fish to and through the fish passage facilities.
- Specific Objectives:
  - Develop and calibrate 3D models of areas pertinent to fish passage structures including the Essex Powerhouse forebay and downstream bypass, tailrace, and fish lift
  - Simulate various operational conditions using each model; and
  - Produce a series of color contour maps depicting flow fields relating to attraction and hydraulics.

Three-Dimensional Computational Fluid Dynamics Modeling: Study Area

- The study area includes upstream of the Essex Powerhouse intakes and dedicated fish bypass in the forebay, downstream of fishway entrances in the tailrace, and internally within the fish lift.

Three-Dimensional Computational Fluid Dynamics Modeling: Project Nexus

- Diadromous fish migrating upstream and downstream in the Merrimack River as part of their life cycle encounter the Lawrence Project. Potential effects of Project operations and facilities include upstream and downstream passage effectiveness and efficiency.
- The development of CFD models relative to the fish passage facilities will provide information regarding hydraulic conditions related to the passage routes.



Three-Dimensional Computational Fluid Dynamics Modeling: Study Methodology

- CFD models will be developed, and simulations of various operational conditions will be run to investigate the hydraulic conditions of the fish passage structures and their approach areas. In order to complete this study, several tasks will be completed: Bathymetric survey and 3D velocity data collection, model construction and calibration, and model simulation runs.
- Bathymetric Survey
  - Essex preliminarily proposes to model areas pertinent to fish passage, as described herein, but anticipates conducting a working group meeting(s) with the MRTC in the summer/fall of 2024 to discuss the appropriate domains and mesh size of areas to be surveyed and modeled. If necessary for model development, surveys will be conducted using an Acoustic Doppler Current Profiler (ADCP) or Ortho imagery Light Detection and Ranging (LiDAR) to collect bathymetry, depth, and 3D flow data. Velocity data within the fish lift entrances will be collected with an ADCP, LiDAR, or Acoustic Doppler Velocimeter (ADV).

Three-Dimensional Computational Fluid Dynamics Modeling: Study Methodology

- Model Construction and Calibration
  - Essex proposes to construct 3D models for three areas pertinent to fish passage: The Essex Powerhouse forebay and downstream bypass, The Essex Powerhouse tailrace and, The Essex Powerhouse fish lift.
  - The field collected bathymetry data and Project elevation data will be used to construct 3D surfaces of the riverbed in the forebay and downstream bypass, tailrace, and fish lift study areas. Project drawings will be used to develop 3D representation of the fish passage structures and other pertinent Project facilities and compiled into a full computer aided drawing (CAD) representation for each of the model areas. The CAD files will then be used to build 3D hydraulic models. Then field collected water surf ace and flow data will be used to run calibration/validations scenarios.

- Model Simulation Runs
  - The calibrated and validated models will be used to run simulations under various input operational scenarios. Essex has developed a suite of potential simulation runs based on stakeholder study requests but anticipates conducting working group meeting(s) to discuss scenarios to be simulated.

Three-Dimensional Computational Fluid Dynamics Modeling: Study Methodology

- Proposed simulations include:
  - Essex Powerhouse Forebay and Downstream Bypass Model With downstream bypass set at normal operating conditions at recommended settings:
    - River flow 1,000 cfs, typical unit setting
    - River flow 3,000 cfs, typical unit setting
    - River flow 8,000 cfs, both units full generation
    - River flow 16,000 cfs, both units full generation
  - Essex Powerhouse Tailrace Model Tailrace model with fish lift at recommended settings:
    - River flow 1,000 cfs, typical unit setting
    - River flow 3,000 cfs, typical unit setting
    - River flow 8,000 cfs, both units full generation
    - River flow 16,000 cfs, both units full generation
  - Essex Fishway Model With attraction water system flow to be calculated by the model with both entrances operating at recommended settings:
    - River flow 1,000 cfs, typical unit setting (i.e., low tailwater condition)
    - River flow 8,000 cfs, both units full generation
    - River flow 12,000 cfs, both units full generation
    - River flow 24,000 cfs, both units full generation (i.e., high tailwater condition).

Three-Dimensional Computational Fluid Dynamics Modeling: Analysis and Reporting

- A report will be developed to include maps, cross-sections, and other representations of the simulation results that are relevant to the study objectives, as well as a summarization of findings relevant to the objectives of the study. Essex anticipates that the Three-Dimensional CFD Modeling study report will include the following elements:
  - Project information and background,
  - Study area,
  - Methodology,
  - Study results,
  - Analysis and discussion,
  - Any agency correspondence and or consultation, and
  - Literature cited.

Three-Dimensional Computational Fluid Dynamics Modeling: Schedule, Level of Effort, and Cost

- Essex anticipates holding a working group meeting with the MRTC following the issuance of the SPD to review and refine the appropriate domains and mesh size of areas to be surveyed and modeled. Essex anticipates collecting the bathymetric data in the summer/fall of 2024.
- Due to diverse locations and accessibility of the areas to be surveyed in the forebay, tailrace, fish bypass and within the fish lift, potentially four bathymetric and flow data collection surveys will be needed. Separate CFD models will be constructed and the recommended simulations run in the winter of 2024/2025.
- Essex anticipates filing the final report concurrent with the ISR. The preliminary estimated cost for this study is $170,000 – $200,000.

Requested Studies Not Adopted

Fish Assemblage Study

- USFWS and MassWildlife requested a Fish Assemblage Study, with the stated goal to determine the assemblage of fish species present in the areas affected by the Lawrence Hydroelectric Project.
- Study request is not necessary because existing information is sufficient to answer the questions posed and the study request constitutes basic research (Study Criteria Nos. 4 and 5).
  - The fishery in the Merrimack River is well-studied, with an established Merrimack River Technical Committee and comprehensive management plans.

- There is no evidence of a problem and/or the study request is an attempt to search for a **problem or "nexus" (Study Criteria No. 5).**
  - As requested, the study would entail extensive sampling in over 41 miles of the Merrimack River and covering three seasons, which would be unlikely to yield meaning full results which would inform the conditioning of the new license.
  - Essex is proposing targeted fish studies and downstream fish passage measures to study or mitigate known concerns (Upstream Anadromous and American Eel, 3D CFD Models).

Fish Passage Improvement and Feasibility Assessment

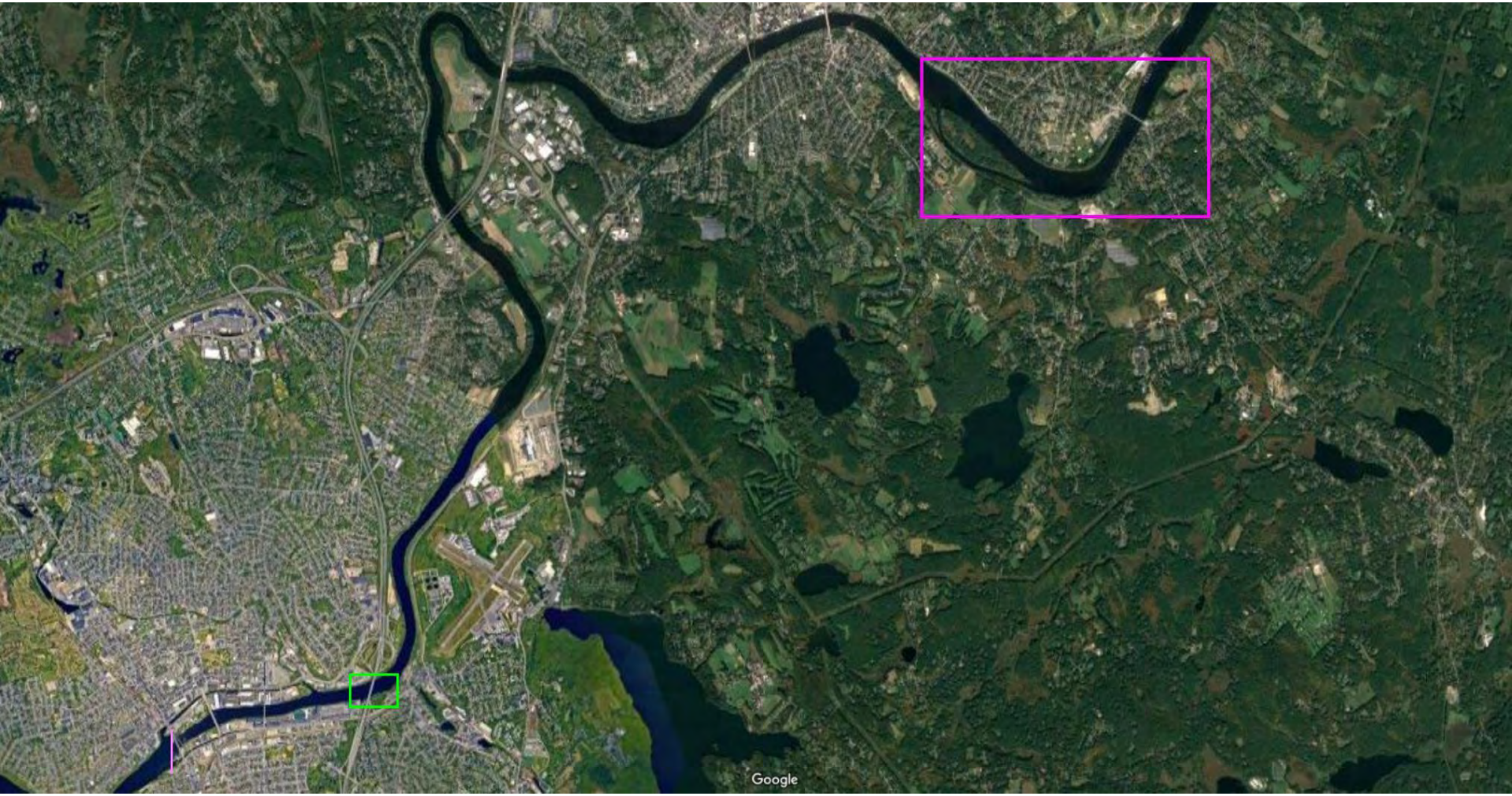
- USFWS, MADMF, NHFG, and MassWildlife requested a Fish Passage Improvement and Feasibility Assessment. The stated goal of this study is to utilize information acquired through the implementation of other relevant relicensing studies to assess the need and feasibility for upstream and downstream fish passage improvements at the Project.

- **Alternative methods or approaches are sufficient to meet the requestor's stated information** needs (Study Criteria No. 7).
- Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4).
  - As stated by the requestors, the study as proposed largely utilizes existing information or information expected to be obtained from other relicensing studies to perform an additional assessment.
  - The fish passage studies Essex is proposing will evaluate the effectiveness of the existing Project passage facilities and operations. If facility enhancements for passage are needed at the Project, a review of passage alternatives may be prudent at that point. At the conclusion of the fish passage studies, Essex will summarize recommended next steps in its study report or in the DLA.

Sturgeon Habitat Mapping and Assessment Study

- NMFS and MassWildlife requested a Sturgeon Habitat Mapping and Assessment Study. The goal of this study is to map and assess sturgeon habitat affected by the Project within the Lawrence Project boundary, including the Project impoundment, and downstream reach of the Merrimack River.

- There is no evidence of a problem/understanding of how the study would be used to inform license requirements, as well as the study request is an attempt to search for a problem or **"nexus" (Study Criteria No. 5).**
- Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4).
  - It is not clear how the Project's ROR operations would be modified under a new license based on the results of the study.
  - Sturgeon have not been observed at the Project and are not an immediate priority in comprehensive management plans.
  - Sturgeon have been detected as far upstream as the I-495 bridge in Lawrence (Stantec 2023) but known sturgeon habitat is ten miles downstream from the Project dam and within the tidal portion of the Merrimack River.
  - Stantec 2023 showed fewer sturgeon aggregations near the western (upstream) portion of Hale's Island.



Hale's Island

I-495 Bridge - Lawrence

Sturgeon Distribution and Project Interaction Study

- NMFS, NHFG, MassWildlife, and USFWS requested a Sturgeon Distribution and Project Interaction Study. The goal of this study is to determine if Atlantic and shortnose sturgeon are interacting with the Lawrence dam tailwater, tailrace, or project works (e.g., draft tubes) and identify potential take during Project operations.
- There is no evidence of a problem or how the study would be used to inform license **requirements, as well as the study request is an attempt to search for a problem or "nexus"** (Study Criteria No. 5).
- Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4).
  - Sturgeon occur in the Merrimack River in low numbers and are not known to approach the Project.
  - The study as requested covers two years of periodic sidescan sonar surveys to account for the "to account for the low density of sturgeon at the Project" involving a significant amount of labor for likely minimal information about sturgeon at the Project, and not enough information to inform license requirements for an ROR Project.
  - Requestors ask for an acoustics telemetry study. Essex considers a robust telemetry study inappropriate for fish species not identified at the Project and not included as a passage priority in comprehensive management plans.

Climate Related Project Impacts on Shortnose Sturgeon Habitat

- Requested by NMFS and MassWildlife. The goal of the study is to determine the risks of increased Project effects during the course of the new license on shortnose sturgeon overwintering, spawning, and rearing habitat downstream of the Project due to saltwater intrusion, altered temperature regime, and changing hydrology in the Merrimack River.

- Study request constitutes basic research/there is no evidence of a problem or how the study would be used to inform license requirements, as well as the study request is an attempt to **search for a problem or "nexus" (Study Criteria No. 5).**
  - It is unclear how such a hypothetical analysis would inform license conditions for this ROR Project.
  - The state of the science is such that climate change forecasts do not exist that could reliably predict how precipitation, saltwater intrusion, snowmelt, evapotranspiration, ice out, and annual runoff patterns may change 30 to 50 years from now.
  - National Environmental Policy Act defines "effects" as changes to the human environment from the proposed action that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action. Effects should generally not be considered if they are remote in time (such as this request), geographically remote, or the product of a lengthy causal chain.

Evaluation of Alternatives to Minimize Project Impacts and Support Climate Resilience of the City of Lawrence and the Merrimack River Ecosystem

- Requested by MassWildlife and TNC. The stated goal of this study is to identify and evaluate alternatives, including modifications to the current project, to minimize project impacts and benefit the resilience of the local community and Merrimack River ecosystem.
- There is no evidence of a problem or how the study would be used to inform license requirements (Study Criteria No. 5).
- Study request proposes a methodology that is untried or uncertain, or proposed a methodology that will not meet the stated objective or yield the intended results (Study Criteria No 6).
  - Potential climate changes that may occur over the course of a 30- to 50-year license are far too speculative to allow for a qualitative or quantitative evaluation as requested.
  - The study request would require Essex to conduct studies on effects caused by other factors over which the licensee has no control (e.g. brown-outs and integrated solar) and is, therefore, contrary to FERC's guidance.
  - Furthermore, it appears that the intent of the study request is to replace the existing project with various alternative sources of electricity. FERC's preliminary permit and/or Declaration of Intent processes would be the applicable forum to pursue such Projects.

Evaluation of Potential Project Impacts on the Merrimack River and Floodplain Habitats throughout the Term of a New License

- Requested by MassWildlife and TNC. The goal of this study is to assess project effects on hydrology, hydraulics and associated ecosystem components and functions, as well as related effects on the local community.
- There is no evidence of a problem or how the study would be used to inform license requirements (Study Criteria No. 5).
- Study request proposes a methodology that is untried or uncertain, or proposed a methodology that will not meet the stated objective or yield the intended results (Study Criteria No 6).
  - Potential climate changes that may occur over the course of a 30- to 50-year license are far too speculative to allow for a qualitative or quantitative evaluation as requested.
  - It is not clear as to how the requested study would inform the Project's influence on any Merrimack River or floodplain habitats.
  - "Effects" under NEPA are reasonably foreseeable and have a reasonably close causal relationship to the proposed action. Effects should generally not be considered if they are remote in time (such as this request), geographically remote, or the product of a lengthy causal chain.

State-listed Odonates and Assemblage Study

- MassWildlife requested a study of State-Listed Odonates, Baseline Data Collection, and Assessment of Operational Impacts. The goal of this study is to characterize the emerging rare riverine odonate (dragonflies and damselflies) assemblage and its habitat within the affected Project area and assess the Project's potential impact.
- There is no evidence of a problem and/or the study request is an attempt to search for a **problem or "nexus" (Study Criteria No. 5).**
  - MassWildlife only indicates a possibility of an effect and needs a study to determine if a Project effect might actually exist.
  - The discharge, water levels, and rate of water level change are dependent on natural incoming Merrimack River flows. The Project is limited to operating in an ROR mode by reacting to and passing inflows, therefore the Project is not fluctuating its upstream impoundment (e.g., store and release or peaking operations) resulting in water elevation changes that may affect potential odonates.
  - Given the Project's current and proposed operations, Essex views this study as general research as compared to a study to measure the direct impact of project operations on a known resource.

Invasive Plant Baseline Survey

- USFWS and MassWildlife requested Invasive Plant Baseline Study, The stated goals of the study are to: (a) characterize and describe the invasive plant species associated with the Project and its area of effect; and (b) determine if and how the Project may be affecting and/or contributing to the establishment and spread of new or existing invasive plant species.
- There is no evidence of a problem and/or the study request is an attempt to search for a **problem or "nexus" (Study Criteria No. 5).**
- The presence of invasive species change is a natural occurrence and/or a likely result of factors unrelated to the operation of the Project.
- Performing an invasive plant species survey at the Project is not justified, as it would only represent a snapshot in time and would not be useful for informing conditions associated with normal operations.
- As noted in the Commission's AIR, Essex will describe any current or proposed measures used to control non-native, invasive plant species within the Project boundary in the DLA.
- The Project is limited to operating in an ROR mode by reacting to and passing inflows.

CSO and Drinking Water Intake Interactions within Project Area

- The MRWC requested a Combined Sewer Overflow (CSO) and Drinking Water Intake interactions within Project Area Study. The goal of this study is to discover how water quality is impacted by CSO's within the Project area and how that affects drinking water treatment for communities withdrawing water from the reservoir and recreational opportunities within the project area.
- There is no evidence of a problem and/or the study request is an attempt to search for a **problem or "nexus" (Study Criteria No. 5).**
- Study request does not propose a specific methodology, proposes a methodology that is untried or uncertain, or proposed a methodology that will not meet the stated objective or yield the intended results (Study Criteria No 6).
  - The Project is operated as an ROR plant with no bypassed reach, meaning inflows to the Lawrence Project match outflows below the Project. In addition, given the seasonal and annual flows of the Merrimack River, the residence time of water flowing through the Project and its impoundment is limited, which is entirely driven by inflow received from upstream.
  - CSO infrastructure and drinking water intakes are outside of Essex's control, and as such, potential Project effects are unlikely to have any measurable, causal relationship with CSOs impacts, and such a study would not inform the development of license requirements.

Water Quality Study (Adopted in Part)

- MADEP and FERC requested a water quality study with the goal to understand current water quality conditions and assess any effects of Project operations.
- Essex is proposing the water quality recommended by FERC, with certain elements from the MADEP request.
- There is no evidence of a problem and/or the study request is an attempt to search for a **problem or "nexus" (Study Criteria No. 5).**
- Study request is not necessary because the study request constitutes basic research (Study Criteria Nos. 4 and 5).
  - MADEP requests parameters including phytoplankton samples, algae, nutrients, sediment sampling, and toxicants. MADEP does not provide any evidence or present a problem with any of these parameters within or downstream of the Project boundary, and thus, the study request appears to be a request for basic research.
  - Potential Project effects are unlikely to have any measurable, causal relationship with parameters such as phytoplankton, attached algae (periphyton), nutrients (total phosphorus and total nitrogen), chloride, and Escherichia coli (E. coli), polychlorinated biphenyls (PCBs), heavy metals, polycyclic aromatic hydrocarbons (PAHs), cyanotoxins, or pesticides in the impounded area or in fish tissue.

Fish Stranding and Ramping Rate Study (Adopted in Part)

- MADMF, NHFG, MassWildlife, and USFWS requested a Fish Stranding and Ramping Rate Study. The goal of the study is to provide information on fish stranding at the Project as it relates to the Project's facilities and operation and maintenance.
- Essex is adopting the majority of the requested study but is not proposing Phase 1 Task 2: Field Surveys.
- **Alternative methods or approaches are sufficient to meet the requestor's stated information** needs (Study Criteria No. 7).
- Study request does not propose a specific methodology, proposes a methodology that is untried or uncertain, or proposed a methodology that will not meet the stated objective or yield the intended results (Study Criteria No 6).
  - The methodology is fairly broad—it is not clear what is considered an operational change (e.g. turbine change, unit outage) that triggers the need for a field survey, and requestors do not identify a seasonal timeframe or geographic extent of the surveys. As requested, the study methods assume fish stranding events would occur under any or all of these conditions even though only two stranding events (2019 and 2023) have been identified at the Project.
  - Essex does not believe these extensive surveys would be productive.

Recreation Facilities, Use, and Aesthetics Study (Adopted in Part)

- FERC recommended Essex perform surveys, personal interviews, and field reconnaissance at formal (Project) and informal (non-Project) recreational facilities within or adjacent to the Project boundary.
- Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4).
- There is no evidence of a problem or how the study would be used to inform license requirements (Study Criteria No. 5).
  - Essex believes instead that a robust literature review, the field inventory, and the visual survey for vegetation and waterborne trash are sufficient to meet study goals (as described above) and to answer the questions posed. Essex will summarize recommended next steps in its study report or in the DLA.
  - Given the dense, urban nature of the City of Lawrence, it is not clear how surveys and reconnaissance at many facilities not owned or operated by Essex will provide meaningful study results to inform license requirements. Essex cannot unilaterally affect direct, substantive change upon facilities they do not own or operate.
  - Conversely, there are also significant health and safety risks to sending technicians to various recreation sites to perform visitor-intercept surveys at locations such as informal river access points and trailheads. Such conditions can create very unsafe situations for both survey staff and the public.

Upstream Anadromous Fish Passage Assessment (Adopted in Part)

- NMFS, USFWS, MADMF, MassWildlife, and NHFG requested formal study requests related to the evaluation of upstream passage effectiveness for migratory fish species.
- Essex is proposing an Upstream Anadromous Fish Passage Assessment. However, Essex is not proposing to evaluate sea lamprey.
- There is no evidence of a problem or how the study would be used to inform license **requirements, as well as the study request is an attempt to search for a problem or "nexus"** (Study Criteria No. 5).
  - Essex does not propose to evaluate the effectiveness of the existing upstream fish passage facilities for sea lamprey as it is not clear how this evaluation would inform license requirements.
  - Sea lamprey passed and/or identified at the Project have been in relatively low abundance. As such, the level of effort and additional expense required to complete this portion of the requested study is not commensurate with the number of sea lamprey potentially available for upstream passage.
  - Generally though, sea lamprey tend to pass using upstream passage structures designed for alosines and Essex believes the study as proposed is sufficient to understanding sea lamprey at the Project.

Downstream Fish Passage Studies

- Essex anticipates providing proposed protection, mitigation, and enhancement measures (PM&Es) to limit or prevent fish entrainment through the Project's turbines. In particular, Essex is proposing to develop, in consultation with the MRTC, a narrow-spaced trashrack design to replace the existing trashrack system.
- Essex believes this proposal for a PM&E measure to screen the Project's intake would greatly inform the new Project proposal and would likely result in reduced study cost.
- Given that Essex is proposing PM&E measures related to fish entrainment and passage, Essex is not proposing to perform the Desktop Entrainment, Impingement, and Turbine Passage Survival Study recommended by FERC. Essex is also not proposing to perform the Downstream Fish Passage Assessment for diadromous species recommended by NMFS, USFWS, MADMF, MassWildlife, and NHFG, with the understanding that the downstream fish bypass survival for emigrating diadromous species will need evaluation at a later date.

Diadromous Fish Behavior, Movement, and Project Interaction Study

- Essex is not proposing the Diadromous Fish Behavior, Movement, and Project Interaction Study as requested by MADMF, NHFG, NMFS, MassWildlife, and USFWS.
- Essex recognizes the importance of the goals of the study to assess migratory fish behavior in and around the Lawrence tailrace. As requested, the study recommends both two-dimensional (2D) and three-dimensional (3D) acoustic tracking of migratory species.
- However, the design of this study would be greatly informed by, and is also largely contingent on, the results of the Three-Dimensional Computational Fluid Dynamics Modeling Study.
- With such advanced technology it will also have logistical and functional limitations and a high study cost (Essex-estimated at $750,000 – $1,000,000).
- Given the unknowns around the methods, and the high cost, Essex believes that planning and designing this study is more efficient as informed by with the results of the CFD Modeling Study in hand. Essex anticipates developing the details of this study in consultation with the MRTC at a more appropriate time.

Closing

Process Plan and Schedule

Major Milestones	Responsible Party	Dates
File PAD and NOI (18 CFR §5.5(d))	Essex	June 16, 2023
File Proposed Study Plan (PSP) (18 CFR §5.11)	Essex	November 28, 2023
Study Plan Meeting(s) (18 CFR §5.11(e))	Essex	January 11, 2024
Comments on PSP (18 CFR §5.12)	Stakeholders	March 11, 2024
File Revised Study Plan (RSP) (18 CFR §5.13(a))	Essex	April 10, 2024
Comments on RSP (18 CFR §5.13(b))	Stakeholders	April 25, 2024
Issuance of Study Plan Determination (18 CFR §5.13(c))	FERC Director	May 10, 2024
Initial Study Report (18 CFR §5.15(c))	Essex	April 26, 2025
File Updated Study Report (18 CFR §5.15(f)) (if necessary)	Essex	April 26, 2026
File Draft License Application (18 CFR §5.16(a))	Essex	July 3, 2026
File Final License Application (18 CFR §5.17)	**Essex**	**November 30, 2026**

PSP and Revised Study Plan: Stakeholder Participation

- Comments on the PSP are due to FERC by March 11, 2024.
- Proposed modification to the PSP must address the seven FERC study criteria in 18 CFR § 5.9(b).
- Comments should be filed with FERC and include the FERC Project number in the subject line (P-2800). These documents will also be available from FERC's elibrary under Docket P-2800.

- Stakeholders can contact Essex with questions or comments:

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Hydro Licensing Manager
Patriot Hydro, LLC
670 N Commercial Street, Suite 204 Manchester, NH 03101
(978) 935-6039
kwebb@patriothydro.com

Lawrence Hydroelectric Power Project (FERC. No. 2800)

Proposed Study Plan Meeting

January 5, 2024
9 AM Start

Meeting Agenda

Agenda Item/Study	January 5th Schedule
Recreation Facilities, Use, and Aesthetics Study	9:00 AM – 9:45 AM
Historically Significant Waterpower Equipment Study	9:45 AM – 10:30 AM
Condition Assessment of Historic Properties and Associated Canal System	10:30 AM – 11:15 PM
Lunch Break	11:15 PM – 12:15 PM
Review of Study Requests Not Adopted	12:15 PM – 1:30 PM

Meeting Objectives

- Essex is pursuing a new license for the Project from the Federal Energy Regulatory Commission (FERC or Commission) in accordance with FERC's Integrated Licensing Process (ILP) at 18 CFR Part 5.
- Pursuant to the ILP, Essex developed a Proposed Study Plan (PSP) that was filed with the Commission on November 28, 2023.
- The objectives of this PSP Meeting are to:
  - Clarify the PSP and any stakeholder information gathering or study requests;
  - Address any outstanding issues regarding the PSP; and
  - Review process plan and schedule and key dates.

Process Plan and Schedule

Major Milestones	Responsible Party	Dates
File PAD and NOI (18 CFR §5.5(d))	Essex	June 16, 2023
File Proposed Study Plan (PSP) (18 CFR §5.11)	Essex	November 28, 2023
Study Plan Meeting(s) (18 CFR §5.11(e))	Essex	January 11, 2024
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File Final License Application (18 CFR §5.17)	**Essex**	**November 30, 2026**

PSP and Revised Study Plan: Stakeholder Participation

- Comments on the PSP are due to FERC by March 11, 2024. Proposed modification to the PSP must address the seven FERC study criteria in 18 CFR § 5.9(b)
- Formal comments should be filed with FERC and include the FERC Project number in the subject line (P-2800). These documents will also be available from FERC's elibrary under Docket P-2800.

- Stakeholders can contact Essex with questions or comments:

Kevin Webb
Hydro Licensing Manager
Patriot Hydro, LLC
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(978) 935-6039
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- Essex will file the Revised Study Plan (RSP) on or before April 10, 2024.

Recreation Facilities, Use, and Aesthetics Study

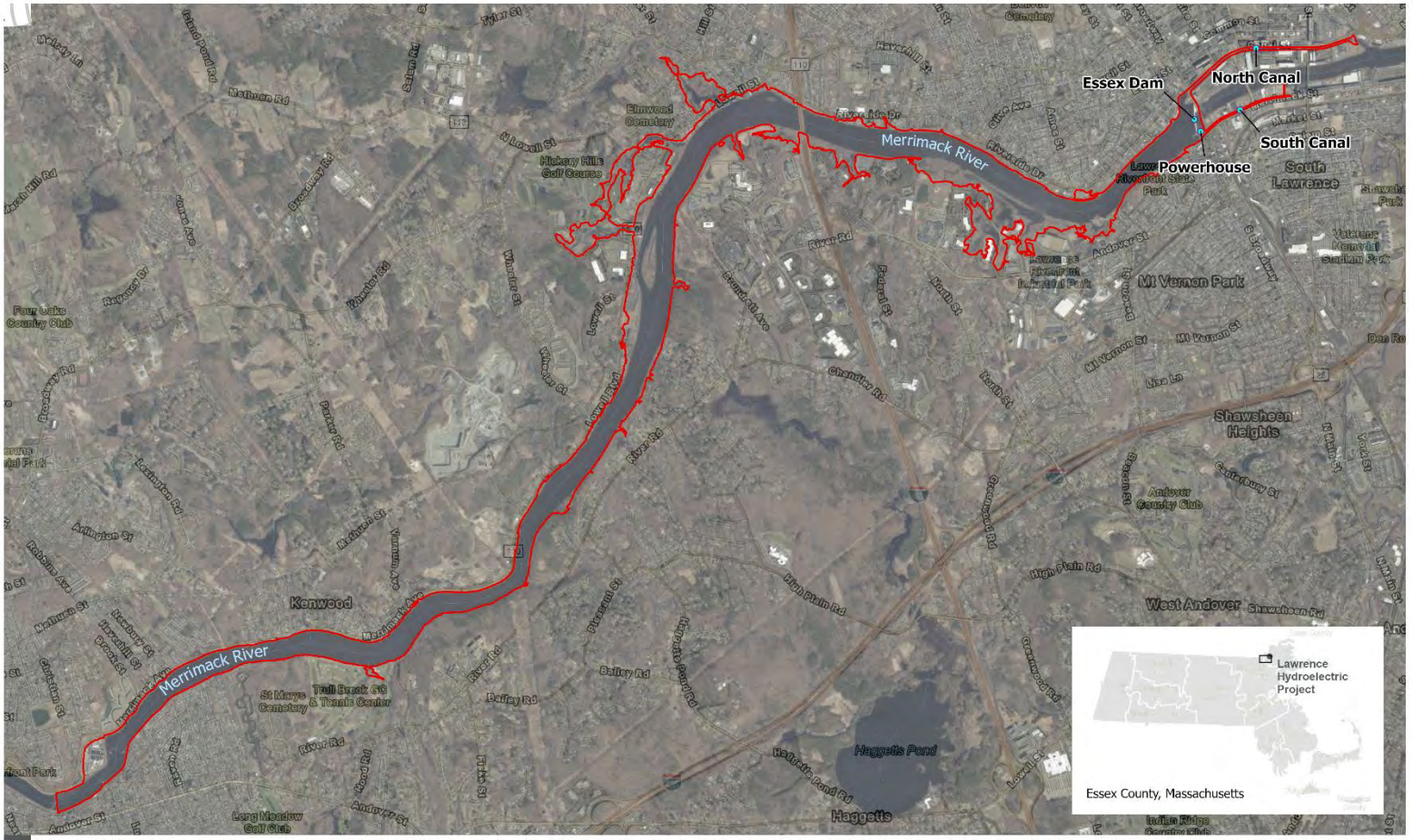
Recreation Facilities, Use, and Aesthetics Study: Goals and Objectives

- Study Goals: (a) document existing recreation facilities and recreational activities that occur at the project, (b) determine the adequacy and capacity of existing recreational facilities to accommodate current and future recreational needs, and (c) identify areas within the canal system where vegetation growth on historic canal walls and waterborne trash occur.

- Study Objectives:
  - Identify existing recreation facilities within and adjacent to the project boundary;
  - Quantify current recreational use based on consultation with stakeholders, regional and statewide plans, and other available data;
  - Identify recreational use types based on consultation with stakeholders;
  - Identify areas of concentrated trash with the canals and vegetation growth on historic canal walls; and
  - Gather information on the condition of Essex's recreation facilities and identify need for improvement.

Recreation Facilities, Use, and Aesthetics Study: Study Area

Essex proposes a general study area that includes the FERC Project Boundary and adjacent recreation facilities.



Recreation Facilities, Use, and Aesthetics Study: Background and Existing Information

- Existing information was summarized in Section 5.8 of PAD
- The Merrimack River provides extensive recreational opportunities. Activities such as boating, canoeing, kayaking, rowing, fishing, and swimming take place on the river. The surrounding vicinity is used for walking, hiking, cross-country skiing, picnicking, bird watching, nature study, and overall enjoyment of scenic views.
- There are several parks and conservation areas located in the vicinity of the Project. These parks offer a variety of amenities including walking trails, picnic areas, gazebos, park benches, fishing access, a boat trailer ramp, and a visitors' center. The most popular recreational activities in the project area are boating, paddling, and hiking

Recreation Facilities, Use, and Aesthetics Study: Project Nexus

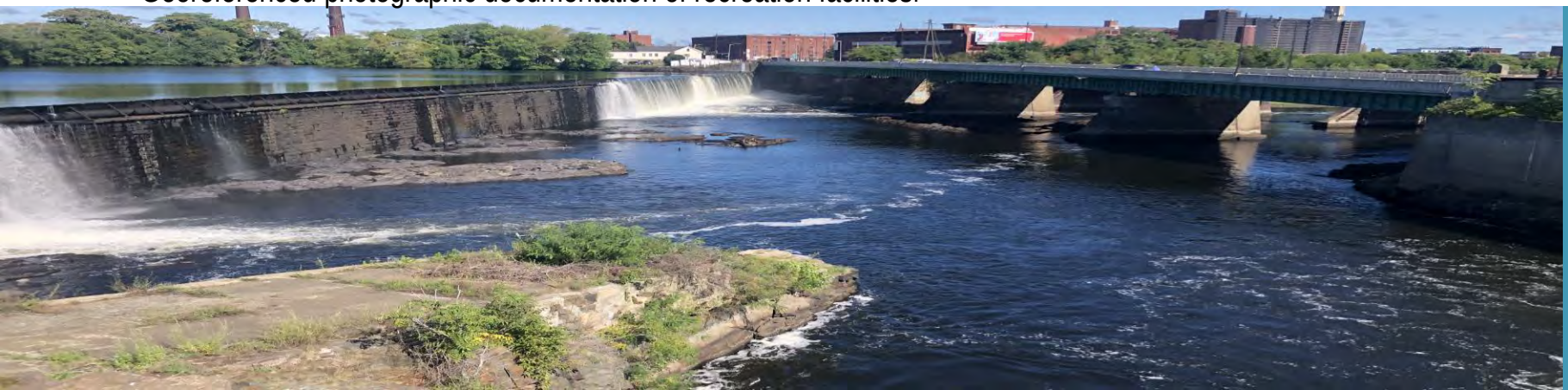
- The principal facilities that comprise the Lawrence Project are located in a largely urban area and adjacent to recreational facilities including Lawrence Heritage State Park, Riverfront State Park, Pemberton Park, and Ferrous Park. Project facilities, including the canal system and historic infrastructure, attract tourists and feature prominently in recreational activities within the parks.
- Project operations have the potential to affect recreational use and aesthetics within the various parks in the Project area and the City of Lawrence.
- The results of this study, in conjunction with existing information, are sufficient to inform resource discussions within the license application materials.

Recreation Facilities, Use, and Aesthetics Study: Study Methodology

- Literature Review
  - Prior to conducting a field inventory, Essex will conduct desktop research and a literature review to identify and describe recreational uses in the Project area. As a component of this research, Essex will review existing recreational uses and facilities management plans (as applicable) related to the Project area including:
    - The Massachusetts Statewide Comprehensive Outdoor Recreation Plan (SCORP)
    - The Lawrence Open Space and Recreation Plan (OSRP)
    - The Lawrence Canal District Revitalization Strategy (2007)
    - The City of Lawrence Canal Wall Assessment (2019)
    - The Lawrence Gateway Project (2004)
    - The Reviviendo Gateway Initiative Campaign (2002)
    - The Massachusetts Recreational Trails Program Guide;
    - The City of Lawrence Parks and Open Space and Recreation Plan (2017- 2024);
    - The Groundwork Lawrence Environmental and Open Space Improvements
    - The City of Lawrence Capital Improvement Plan (2019-2023);
    - Publicly available geospatial data from the State of Massachusetts and City of Lawrence.
  - Essex will issue a data request to interested stakeholders to provide relevant documentation or applicable guidance documents for inclusion in the literature review. Stakeholders to be contacted as part of this data request include: Groundwork Lawrence, Lawrence Redevelopment Authority, City of Lawrence, MADCR, and Lawrence CommunityWorks.

Recreation Facilities, Use, and Aesthetics Study: Study Methodology

- Field Inventory
  - Essex will conduct a field inventory to document existing Project and non-Project recreation facilities within or adjacent to the Project Boundary. The inventory will include a brief description of the site, a catalog of the facilities and amenities provided at the site, photographs of the site, and an estimate of parking capacity provided at the site. Locations of recreational facilities will be recorded and mapped using GPS. Essex will also record other relevant and applicable information for each recreational facility including:
    - A description of the type and location of existing recreational facilities;
    - Property Ownership
    - The type of recreation provided (boat access, angler access, picnicking, etc.)
    - Recreational use and capacity of existing recreational facilities;
    - Existing amenities and sanitation;
    - The type of vehicular access and parking (if any);
    - Suitability of facilities to provide recreational opportunities and access for persons with disabilities (i.e., compliance with current Americans with Disabilities Act. standards for accessible design); and
    - Georeferenced photographic documentation of recreation facilities.



Recreation Facilities, Use, and Aesthetics Study: Study Methodology

- Visual Survey for Vegetation and Waterborne Trash
  - Essex will survey the North Canal and South Canal on foot or by boat to visually inspect and document vegetation and waterborne trash within the study area.
  - Essex anticipates conducting a survey for vegetation at the end of the growing season (e.g., August/September). If conditions are appropriate.
  - Essex will simultaneously perform the survey for waterborne trash. Observations will be recorded regarding vegetation type, depositional setting, and evidence and location of waterborne trash. Data collected during this portion of the survey will include detailed field notes, site sketch maps, and photographic documentation.
  - Essex will map vegetation growth along the historic canal walls and concentrations of waterborne trash using GPS. Using the results of this task, Essex will develop maps showing locations of large accumulations of vegetation and waterborne trash present in the study area.

Recreation Facilities, Use, and Aesthetics Study: Analysis and Reporting

- Essex will prepare a report summarizing the results of the Recreation Facilities, Use, and Aesthetics Study to include information presenting the results of the literature review, field inventory, and visual surveys for vegetation and waterborne trash. Essex anticipates the Recreation Facilities, Use, and Aesthetics Study Report will include the following elements:
  - Project Introduction and Background
  - Study Area
  - Methodology
  - Study Results,
  - Analysis and Discussion,
  - Location maps, Geographic Information System (GIS) analysis, and photos
  - Any agency correspondence and consultation, and
  - Literature cited.

Recreation Facilities, Use, and Aesthetics Study: Schedule, Level of Effort, and Cost

- Essex anticipates conducting background literature reviews and consultation with stakeholders immediately following issuance of the SPD. Essex anticipates conducting the field inventory in the summer of 2024 and the vegetation and waterborne trash survey in fall 2024.
- Essex anticipates filing the final study report concurrent with the ISR.
- Essex anticipates that this study will cost approximately $50,000 to complete.

Historically Significant Waterpower Equipment Study

Historically Significant Waterpower Equipment Study: Goals and Objectives

- Study Goal: identify and document historically significant waterpower equipment located within the canals and canal gatehouses, and identify the potential for future interpretation, exhibition, and preservation methods of identified resources, in consultation with the MHC, which serves as the state historic preservation office (Massachusetts SHPO), the Lawrence Historical Commission (LHC), and other interested parties.
- Specific Objectives:
  - Consult with the Massachusetts SHPO, the LHC, and other interested parties and conduct a site visit to identify historically significant waterpower equipment of interest to stakeholders for potential future interpretation, exhibition, or as scrap equipment to maintain and operate other historic machinery
  - Photo-document historically significant waterpower equipment identified in consultation with the Massachusetts SHPO, the LHC, and other interested parties;
  - Conduct background research on the history of identified waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used; and
  - Document current ownership of historically significant waterpower equipment.

Historically Significant Waterpower Equipment Study: Study Area

- The study area includes the Project's historic canal system and the Project's civil works within the Project Boundary.

Historically Significant Waterpower Equipment Study: Background and Existing Information

- The modern hydroelectric facility, including the intake canal, powerhouse, turbines and generators, tailrace, fish passage structures, transmission line, and recreational facilities were constructed pursuant to the current FERC license and were commissioned in 1981.

- The canal system and some certain facilities such as, the Great Stone Dam, the North Canal, and the Locks and Wasteway are listed in the NRHP and are contributing elements to the North Canal Historic District (LAW.A/W) listed in the NRHP on November 13, 1984.

- The South Canal (LAW.908) may be potentially eligible for listing in the NRHP according to Criterion C, given the canal's distinctive type, period, and method of construction. The remaining facilities do not meet the criteria for listing in the SRHP or for the NRHP.

Historically Significant Waterpower Equipment Study: Project Nexus

- The Lawrence Hydroelectric Project is an operating hydroelectric project that requires routine maintenance. Essex maintains, repairs, and replaces mechanical and control equipment at the Project on an as-needed basis. Additionally, Essex continuously evaluates the maintenance and operation of Project facilities to maximize operational efficiency and safety.

- Several Project facilities are located within the North Canal Historic District. Activities such as replacing mechanical equipment or controls or discontinuing maintenance of equipment that is no longer required for safe and efficient Project operations may have an adverse effect on historically significant waterpower equipment.

Historically Significant Waterpower Equipment Study: Study Methodology

- Site Visit and Consultation
  - Essex will coordinate a site visit and visual inspection of historical Project facilities, including the canal gatehouses and canal civil works. For this task, Essex will retain an architectural historian or other professional experienced in historic surveys.
  - Essex will capture photographs of any machinery and equipment more than 50 years in age, within the canals and canal gatehouses (also capturing the spatial arrangements and other details that reveal a machine's function), and any other equipment or facilities identified during consultation. Massachusetts SHPO, LHC, and any other interested stakeholders will be invited to attend this site visit. Essex will provide a summary of the site visit and a list of identified historical equipment (e.g. more than 50 years in age) to the Massachusetts SHPO, Lawrence Historical Commission, and any other interested stakeholders for review and comment.
  - Essex will also provide a list of equipment identified as historically significant that is recommended for additional documentation as noted below. Essex notes that not all historical equipment may be deemed historically "significant".

Historically Significant Waterpower Equipment Study: Study Methodology

- Photography and Documentation
  - Photography
    - Essex will digitally photo-document historically significant waterpower equipment (if any) identified during the site visit and/or in consultation with stakeholders. For this task, Essex will retain an architectural historian or other professional experienced in photo documenting historic industrial and mechanical equipment. While specific photos will depend on the nature and type of equipment, Essex intends to generally capture the following photographs for equipment:
      - » Existing machinery and equipment, also capturing the spatial arrangements;
      - » Machinery details that reveal a machine's function; and
      - » General views and details of structural framing systems.
  - Documentation
    - To the extent possible, Essex will research, document, and summarize relevant information of the history of significant waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used. This historical research and documentation will be conducted by a qualified architectural historian with experience conducting research and documentation of historic industrial equipment. Essex will also document current equipment ownership.

Historically Significant Waterpower Equipment Study: Analysis and Reporting

- Essex will develop a Report on Historically Significant Waterpower Equipment that includes photographs and the historical documentation of waterpower equipment.

  The report will also summarize current equipment ownership. Essex anticipates the Historically Significant Waterpower Equipment Study Report will include the following elements:

  - Project Information and Background,
  - Study Area,
  - Methodology,
  - Study Results,
  - Analysis and Discussion,
  - Location maps, GIS analysis, and photos

Historically Significant Waterpower Equipment Study: Schedule, Level of Effort, and Cost

- Essex anticipates that the site visit and consultation with stakeholders will take place in the summer of 2024.
- Photography and documentation of historically significant waterpower equipment is expected to be conducted in the fall of 2024.
- Essex anticipates filing the Report on Historically Significant Waterpower Equipment with the Commission concurrent with the ISR on April 26, 2025.
- Essex estimates the cost of the Historically Significant Waterpower Equipment Study to be approximately $25,000 – $35,000.

Condition Assessment of Historic Properties and Associated Canal System

Condition Assessment of Historic Properties and Associated Canal System: Goals and Objectives

- Study Goal: Evaluate the potential effects of project operation on historic resources within the project's Area of Potential Effects in consultation with the Massachusetts SHPO, LHC, and other interested parties.

- Specific Objectives:
  - Determine the extent to which project operations, including water flow in the North and South Canals, have an effect on historic properties;
  - Conduct a condition and structural assessment of the North and South Canals; and
  - Identify potential impacts of current and proposed project operations on historic resources.

Condition Assessment of Historic Properties and Associated Canal System: Study Area

- The study area includes the Project's canal system and associated Project infrastructure within the FERC Project Boundary, including:
  - North Canal and South Canal
  - North Canal Gatekeeper's House
  - Great Stone (Essex) Dam, Locks and Wasteway; and
  - A series of bridges (Upper Pacific Bridge, Lower Pacific Bridge, Washington Mills Canal Bridge, Union Street Bridge over North Canal, Boston and Maine North Canal Railroad Bridge, Broadway Bridge, Upper Pacific Cotton Mill Pedestrian Bridge, Amesbury Street Pedestrian Bridge, Washington Mills Building #1 Bridge, Pemberton Mill Bridge and Pemberton Mill Bridge II, Central Bridge, and North Canal Bridge-Central Bridge).

Condition Assessment of Historic Properties and Associated Canal System: Background and Existing Information

- The canal system and some certain facilities such as, the Great Stone Dam, the North Canal, and the Locks and Wasteway are listed in the NRHP and are contributing elements to the North Canal Historic District (LAW.A/W) listed in the NRHP on November 13, 1984.
- The South Canal (LAW.908) may be potentially eligible for listing in the NRHP according to Criterion C, given the canal's distinctive type, period, and method of construction. The remaining facilities do not meet the criteria for listing in the State Register of Historic Places (SRHP) or for the NRHP.

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Condition Assessment of Historic Properties and Associated Canal System: Project Nexus

- Operation of the Project, including manipulation of the Essex Dam crest gate, canal headgates, spillways, and other Project features affects water levels and flows in the historic canal system.

- This study would assess the impacts of Project operations on historic buildings and structures that comprise the canal system.

Condition Assessment of Historic Properties and Associated Canal System: Study Methodology

- Document Review of Existing Conditions
  - Essex will review available architectural and engineering evaluations of historic canal structures available from the City of Lawrence, Massachusetts SHPO, and other stakeholders, including documentation of previous maintenance and repairs to characterize existing conditions. Essex will incorporate the following efforts as a component of this review:
    - Delineation of the APE in consultation with the Massachusetts SHPO
    - Conduct a site visit to historic canal structures to identify issues related to project operation and maintenance, vegetation and debris, and the flow and water levels on historic structures, including non-project historic inlet gates and National Register eligible bridges within the Project boundary.
    - Identify properties that have previously been affected by project operation and maintenance, vegetation and debris, and the flow and water levels.
    - Document dimensions of significant structural features of these properties relative to the water levels in the canals so that the effects of flow into the canals and changes in water levels can be assessed.
    - Conduct a desktop structural engineering assessment of the North and South Canals, including a visual inspection and review of available engineering and architectural drawings, maintenance records, and structural modifications.

Condition Assessment of Historic Properties and Associated Canal System: Study Methodology

- Assessment of Water Levels, Flows, and Project Effects
  - Essex will compare the results of the document review of existing conditions and the water level, flow, and operational data collected in 2024-2025 to identify potential Project-related effects on the historic canal system infrastructure.

Condition Assessment of Historic Properties and Associated Canal System: Analysis and Reporting

- Essex will develop a Report on the Condition Assessment of Historic Properties and Associated Canal System that identifies any Project-related flow or water level effects on the historic canal system infrastructure. Essex anticipates the Condition Assessment of Historic Properties and Associated Canal System Report will include the following elements:
  - Project Information and Background,
  - Study Area,
  - Methodology,
  - Study Results,
  - Analysis and Discussion,
  - Location maps, GIS analysis, and photos,
  - Any agency correspondence and consultation, and
  - Literature cited
- Essex anticipates developing an HPMP to describe how the licensee will consider and manage historic properties within the Project Boundary of potential effects during the term of the new license

Condition Assessment of Historic Properties and Associated Canal System: Schedule, Level of Effort, and Cost

- Essex anticipates that a review of existing documents and site conditions will be initiated in the summer of 2024, and a site visit performed in the fall of 2024.
- Essex anticipates filing the final report concurrent with the ISR on April 26, 2025.
- Essex estimates the cost of the Condition Assessment of Historic Properties and Associated Canal System Study to be approximately $60,000 – $75,000.

Questions on Proposed Studies

Requested Studies Not Adopted

Requested Studies Not Adopted

- During the PSP Meeting on January 4, 2024, Essex and participants reviewed the following studies not adopted:
  - Fish Assemblage Study
  - Fish Passage Improvement and Feasibility Assessment
  - Sturgeon Habitat Mapping and Assessment Study
  - Sturgeon Distribution and Project Interaction Study
  - Climate Related Project Impacts on Shortnose Sturgeon Habitat
  - Evaluation of Alternatives to Minimize Project Impacts and Support Climate Resilience of the City of Lawrence
  - Evaluation of Potential Project Impacts on the Merrimack River and Floodplain Habitats throughout the Term of a New License
  - State-listed Odonates and Assemblage Study
  - Invasive Plant Baseline Survey
  - CSO and Drinking Water Intake Interactions within Project Area
  - Water Quality Study (Adopted in Part)
  - Fish Stranding and Ramping Rate Study (Adopted in Part)
  - Upstream Anadromous Fish Passage Assessment (Adopted in Part)
  - Downstream Fish Passage Studies
  - Diadromous Fish Behavior, Movement, and Project Interaction Study

Closing

Process Plan and Schedule

Major Milestones	Responsible Party	Dates
File PAD and NOI (18 CFR §5.5(d))	Essex	June 16, 2023
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- Proposed modification to the PSP must address the seven FERC study criteria in 18 CFR § 5.9(b).
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